# ON SOME ROTIFERA FROM SPITSBERGEN.

THE OXFORD UNIVERSITY EXPEDITION TO SPITSBERGEN, 1921.

Report No. 16.

By David Bryce.

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Figs. 1–6 in Text.

Having already made a report (1) in 1897 on the Rotifera found in mosses collected by Dr. J. W. Gregory on the occasion of Sir W. Martin Conway's Expedition to Spitsbergen in 1896, I was interested to learn in the autumn of last year that a further series of mosses had been collected by the Oxford University Expedition, and I willingly undertook their examination, being curious to know if it would be possible from them to add to the information already possessed concerning the Rotifera which are able to live so far north. Since 1897 that information has been materially increased. There had been two previous records of Rotifera from Spitsbergen. In 1862 A. von Goes (3) recorded two species of Callidina, which he had found in some moss, but of which he had not determined the species. In 1869 Ehrenberg (2) examined some mosses, which had been collected in 1867, and in them found one rotifer, *Callidina alpium* ( = *Pleuretra alpium*), and an " egg of a rotifer " unknown.

In my report of 1897 I was able to record the occurrence of 26 species, including the single species which had been seen by Ehrenberg.

Richard (9) in the following year recorded having found in Spitsbergen five species, all plankton forms.

In 1906 a large quantity of fresh moss was brought from Prince Charles Foreland by Dr. W. S. Bruce, having been collected by him during the stay there of the Scottish Spitsbergen Expedition of that year. This moss, along with some smaller quantities of older material from Franz Josef Land and Novaya Zembla, etc., was handed by Dr. Bruce to James Murray, at that

time the well-known investigator of Scottish Rotifera. His report on the collection (5) was submitted to the Royal Physical Society of Edinburgh in the autumn of 1907. The Rotifera obtained from the Spitsbergen moss were dealt with separately, though at no great length. I find that of the 19 forms, which he observed, only 5 had been previously recorded by me, and one by Richard, and 13 species were accordingly additions to the Spitsbergen list.

In 1918 Olofsson published (8) an account of researches carried out in the summer of 1910, on the Crustacea and Rotifera observed and collected by himself in numerous lagoons and ponds throughout Spitsbergen and the various islands in the vicinity. All the Rotifera found by him belong to the order Ploïma, and make a considerable contribution to the list of that group, which was only poorly represented in the mosses examined by Murray and myself. Altogether Olofsson enumerates 34 species or well-marked varieties, including several described as new to science. Of the 34 forms 3 had been already seen by Richard, 2 by Murray, and 2 by myself.

In the mosses now reported on I have found 28 species or well-marked varieties. Of these 18 had previously been recorded; and 10 species remain as new records, bringing the total up to 81 species or well-marked varieties.

In considering the results of the three series of moss-gatherings, one cannot help remarking that in each the Bdelloid Rotifera have greatly preponderated, in the number of species obtained, over the Ploïma and Flosculariaceae. In the combined total of 51 species and varieties obtained from mosses, there are 35 Bdelloida, 15 Ploïma, and 1 Floscularian. This apparent disproportion is due to the fact that most of the Bdelloida are habitually moss-dwelling and are rarely or never found in pools or other waters. If collections had been made in the ordinary way from available pools or lagoons, the proportions of these groups would probably have been more than reversed, as has in fact been shown by Olofsson's results. It is not so much a question of temperature as of the customary habitat of the species. Where moss gatherings were made, it resulted that the Rotifera found were principally Bdelloida. A few species of Ploïma are also generally found in mosses. Apart from one Ploïmid which is not known to have been hitherto found in Europe, I find that

among the 51 forms, 34 Bdelloida and 6 Ploïma are species which are rarely or never met with except where moss is present; while 1 Bdelloid, 8 Ploïma and 1 Floscularian are species almost invariably found in pools or deeper waters. The presence of these 10 species in the mosses examined is doubtless to some extent accidental.

At least 70 of the 81 forms enumerated in the full list given later have not only been already found in the more temperate countries of Europe, but are actually more or less common in Great Britain itself; among the species described as new there are no startling variations from already known European species. Thus, so far as they are yet known, the Rotifera of Spitsbergen furnish absolutely no evidence of local evolution. In this connection I may add that a very similar position is shown in the recently published report by Harring (4) on the general plankton collections made by the Southern party of the Canadian Arctic Expedition 1913–1918, which deals with pond or lake-dwelling rotifers only. These plankton collections, made, as I understand, in the north of Alaska, yielded in all 64 species of Rotifera, of which 5 are new to science. Of the remaining 59 species, no less than 50 are to be found in Great Britain and most of them are quite common forms. Although dealing for the most part with quite a different set of species, Harring's list tells much the same tale as does mine, viz. that these species from the far north are practically identical with those living in more temperate countries. It is the nature of the actual habitat, especially as regards the plenteous provision of suitable food, that is the predominant factor in the distribution of Rotifera, and temperature, if not too extreme, has only a secondary influence.

I think, however, that extremes of temperature may in some cases exercise a distinct influence upon the distribution of Rotifera, and that this is shown by Murray's (6) experiences in the Antarctic. Shortly after he had completed his report on Dr. Bruce's collections of mosses from Arctic territories, Murray became biologist to the British Antarctic Expedition, 1907–1909, and investigated the rotifer-fauna of the district near Cape Royds, where the expedition had its base for two summers and the intervening winter. His previous extensive knowledge of Rotifera, whether moss-dwelling or pool-dwelling, peculiarly

fitted him for such an investigation. In the course of his researches he found rotifers both among mosses and in the lakes and ponds. In the former situation they were relatively scarce, while in the lakes they were extremely abundant in individuals, though the number of different species was comparatively small. From the mosses he was only able to obtain two species (one previously unknown), and from ponds and lakes only 14 species (including 4 new forms). I may point out that of these 14 species found in lakes, no less than 5 are species which are known in this country, but are never, or rarely, found in such habitats, while common enough in mosses. As these 5 species were not found in the Antarctic mosses, it may be inferred that the conditions of life in the lakes were more endurable than in the mosses; so much so that these 5 species have abandoned their customary habitat and adopted another of quite a different character, and that not sporadically, but en masse. A second instance of temperature or climatic influence upon the Antarctic Rotifera can be noted. Of the five species described by Murray as new to science, two without any doubt belong to Bdelloid genera whose other members, so far as yet known, are without exception oviparous. These two species, *Adineta grandis* Murray and *Philodina gregaria* Murray, are, on the contrary, viviparous. While other species of the same genera in the same habitat have retained the oviparous method of reproduction, these two species alone show this startling divergence from all known relatives of their respective genera.

The Antarctic list of 16 species of Rotifera resulting from the researches of such an experienced biologist as Murray, carried on for more than a year, compares very poorly with the Spitsbergen list of 81 species, of which 51 were obtained from a few mosses selected by non-expert hands. Two explanations may be suggested for the disparity, each perhaps partly responsible. Firstly, the extreme severity of the conditions of life near Cape Royds, which only a few species have succeeded in enduring. Secondly, the greater accessibility of Spitsbergen—its nearer proximity to countries affected by the beneficent Gulf Stream. I would add that moss-dwelling rotifers with their very exceptional powers of retaining vitality while apparently dust-dry, and with eggs of even greater endurance than the adult animal,

would be much more likely to be distributed by wind-storms or by the agency of birds than would pool-dwelling species.

The hypothesis that the present Rotifera fauna of Spitsbergen has arisen from "accidental peopling" since the period of maximum glaciation seems to me feasible enough, and I do not seek any other solution of the problem of their presence, until some proof is forthcoming that animals having some definite relationship to Rotifera did exist there in still earlier ages.

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The present series of mosses, collected in the months of July and August, 1921, had been in my hands for several weeks before I was free early in January last to commence their examination. I had scarcely started when I was forced to put on one side all microscopic work, and it was not until nearly the end of March that I was able to resume; most of the gatherings were examined in April and May. Although the period of eight or nine months between collection and examination was not excessive from the point of view of the possibility of reviving a large proportion of the Bdelloid Rotifera inhabiting the mosses, an earlier examination would possibly have enabled me to revive some few additional species.

As the examination proceeded it was impressed on me that either the larger species had greater endurance, or they had been better able to protect themselves against the dangers common to both large and small. I found that nearly every individual seen of the larger species, such as *Rotifer sordidus*, *Rotifer tardigradus*, *Macrotrachela habita* and *Mniobia russeola*, revived after a few hours' soaking of the moss, while a comparatively small proportion of the specimens of the smaller species showed the least trace of life. I think I am justified in stating also that the Bdelloid Rotifera showed on the whole a greater power of self-preservation than the eel-worms and water-bears associated with them and subjected to the like conditions.

Among the twenty-eight species found in these recent collections are two which have not hitherto come under my notice. One of these is a practically spineless variety of the widely distributed Bdelloid *Pleuretra Brycei*, a species whose type form is remarkable for a very characteristic row of spines crossing the back. Like most other spine-bearing species, it is subject to almost infinite variation in the number and exact

disposition of the spines. I have not so far been able to find recorded any variety so nearly without spines as that now described.

The other form belongs undoubtedly to the Ploïmid genus Encentrum, one of the most interesting genera of the family of the Notommatidae. It was only after much search that I found that a form which agrees with it in the most important details had been found in the Antarctic and described and figured by Murray in the Report (6) already cited. As his study of the individuals seen was incomplete he did not name the species, but contented himself with assigning it to the genus Pleurotrocha. It is not included in the list of sixteen species recognised or named by him.

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Mr. C. S. Elton, who personally collected the mosses examined, has furnished me with some particulars of the three localities where the various collections were made and of the actual positions of growth, and further, with the names of the mosses which have been identified by Mr. H. N. Dixon.

The latitude of all three localities is between 78° and 79° N.

Prince Charles Foreland : a long island off the west coast of West Spitsbergen. Freshwater Bay, where the collections were made, is on the N.E. side of the island. Here are steep mountains with a narrow coast-belt of flat, rocky or shingly ground ; the mosses were from this region (raised beach by Point Carmichael) and from the foot-hills (Glen Mackenzie).

Mosses collected early July, 1921.

Z 1. *Rhacomitrium lanuginosum* Brid.
From bare and very dry shingle.

Z 2. *Hypnum uncinatum* Hedw.
*Polytrichum alpinum* L.
From sandy area, over shingle.

Z 3. *Dicranum groenlandicum* Brid.
Dry tundra.

Z 4. *Rhacomitrium canescens* Brid., var. *ericoides* B. & S.
From dry scree slope.

The five species of Rotifera obtained from these four gatherings were all present in the Z 1 collection, but in very small numbers, and I revived only isolated examples of the first two

species. From Z 2 were revived three examples only of *Habrotrocha insignis*, but several dead specimens of *Pleuretra alpium* were also seen. In Z 3 and Z 4 I found only a few dead individuals, amongst which I could recognise two as being the var. *hirundinella* of *Macrotrachela plicata*. In these mosses I saw very few specimens of eel-worms, rhizopods, or tardigrades, and of these groups no single individual revived. The exceedingly poor results obtained from these gatherings are perhaps due to the bare positions from which they appear to have been taken.

Rotifers revived:

*Habrotrocha insignis* Bryce.
*Mniobia russeola* (Zelinka).

Not revived:

*Pleuretra alpium* (Ehrenberg).
*Macrotrachela plicata* (Bryce), var. *hirundinella* Murray.
*Habrotrocha* sp. (4-toothed, but not recognisable).

Cap Boheman: a rocky point of land jutting out into Isfjord on the north side of the fjord. It is more or less flat and mostly sandstone rock. The pond from which the sphagnum was taken lay about ½ mile from the coast, less than 50 ft. above sea-level.

Mosses collected early July, 1921.

*Sphagnum* sp.
*Cynodontium virens* Hedw.
*Hypnum brevifolium* Lindb.
*H. cordifolium* Hedw.
From the bank of a pool.

As the sphagnum was dry when received, I had little expectation of securing any living specimens from it, but I took my earliest opportunity of washing a portion, *viz.* early in January. I found in it a very few dead rotifers, some dead tardigrades (and eggs) and several eel-worms. Three moss-mites, apparently of different species, had alone retained vitality. The ground moss I examined early in June, and found a few rotifers, mostly dead, those which revived representing the four species named below. One example of *Mniobia russeola* was infected by an endo-parasitic worm which is described later.

Rotifers revived:

*Adineta vaga* (Davis).
*Rotifer sordidus* (Western).

*Mniobia russeola* (Zelinka).
*Habrotrocha* sp. (not recognisable).

Klaas Billen Bay: a long fjord at the head of Isfjord in West Spitsbergen. Here also are mountains, and between them and the sea a strip of raised beach forms comparatively low, flat ground. The mosses were taken from a location in the neighbourhood of the small collection of huts known as "Bruce City," at the head of the bay.

Mosses collected early August, 1921.

L 1 and 2. *Hypnum vernicosum* Lindb.
*H. stellatum* Schreb.
L 3. *Cinclidium stygium* Sw.
L 4 and 5. *Orthothecium chryseum* Schwaegr.
*Swartzia montana* Lindb.
L 14. *Hypnum cordifolium* Hedw.
From pool with a fresh-water spring, moss mostly submerged.
L 16. *Orthothecium chryseum* Schwaegr.
*Bryum pseudotriquetrum* Schwaegr.
*Swartzia montana* Lindb.
The above from wet or damp edge of a shallow fresh-water lagoon.
L 17. *Camptothecium nitens* Schwaegr.
These from bank of same lagoon in comparatively dry situation.
L 18. *Bryum nitidulum* Lindb. (abnormal).
From edge of salt-marsh.
L 19. *Hypnum stellatum* Schreb.
Damp tundra.
L 21. *Hypnum scorpioides* L.
From very wet situation.
L 25. *Grimmia commutata* Huebn.
Dry tundra.

The mosses from Klaas Billen Bay furnished nearly all the species of Rotifera which are included in the present report.

From L 1 and 2 were obtained dead specimens of several species of ordinary pool-dwelling rotifers which were recognised from the more or less empty but distinctive loricae.

*Monostyla cornuta* (Müller).
*Monostyla lunaris* Ehrbg.
*Mytilina ventralis brevispina* (Ehrenberg).
*Lepadella patella* (Müller).

The following Bdelloids revived :

*Macrotrachela habita* (Bryce).
*Macrotrachela Ehrenbergii* (Janson).
*Adineta vaga* (Davis).
*Adineta burbata* Janson.

Dead specimens of a small species of Habrotrocha, quite unidentifiable, were numerous, and at least two other species did not revive. Many water-bears, eel-worms, and a few Cladocera were seen, but except one water-bear, all were hopelessly dead.

L 3 and 16. These gatherings proved less encouraging, as none of the animals which they had sheltered were revived. In L 16 were a few Rhizopod tests.

L 4 and 5. In these gatherings were found very few rotifers ; only three species revived :

*Adineta gracilis* Janson.
*Macrotrachela multispinosa* Thompson.
*Habrotrocha constricta* (Dujardin).

L 17. In addition to the first of these three species this moss produced :

*Adineta barbata* Janson.
*Macrotrachela habita* (Bryce).

L 14. In the washings from this moss, at least three species of rotifers could be distinguished, but as none of the specimens revived, none could be identified. There were also present a few eel-worms, many diatoms, and a multitude of water-bears, apparently of the genus Macrobiotus. When the moss had been soaked for two days, five water-bears were found to have revived.

L 18. In the washings from this gathering, I found no trace of Rotifera. Dead eel-worms were moderately numerous and some few diatoms were observed. The absence of rotifers was

not surprising in view of the position whence the moss was taken.

L 19. Very few rotifers were seen in two carefully prepared washings; all were dead except a single example of:

*Pleuretra Brycei* (Weber).

L 19. From the damp tundra, two washings produced very few rotifers. Those revived were:

*Adineta vaga* (Davis).
*Adineta barbata* Janson.
*Macrotrachela aculeata* Milne.
*Habrotrocha Milnei* (= *Macrotrachela bidens* Milne).

L 21. This moss produced a better series of species and a fair proportion of living individuals after soaking for 2 to 3 hours; one dead Ploïmid was recognised as:

*Monostyla cornuta* (Müller).

The following Bdelloid species revived:

*Ceratotrocha cornigera* (Bryce).
*Habrotrocha insignis* Bryce.
*Habrotrocha elegans* (Milne).
*Macrotrachela habita* (Bryce).
*Rotifer tardigradus* Ehrenberg.
*Philodina acuticornis* Murray.
*Pleuretra Brycei* (Weber).
*Adineta vaga* (Davis).
*Mniobia russeola* (Zelinka).

There were also seen several Desmids, some Nostoc, several water-bears (of at least two species), several eel-worms, and a few Rhizopod tests. Several of the water-bears and eel-worms came back to active life.

L 25. This material consisted mainly of one large tuft or "slab" of close-growing ground-moss with tightly packed upright stems rather more than an inch high and perhaps the growth of several seasons. It proved to be by far the most productive for Rotifera, although the number of individuals seen was quite moderate. Many washings were made and the following species revived:

*Adineta vaga* (Davis).
*Habrotrocha insignis* Bryce.
*Habrotrocha Milnei* (= *Macrotrachela bidens* Milne).
*Rotifer sordidus* (Western).
*Rotifer tardigradus* Ehrenberg.
*Habrotrocha constricta* (Dujardin).
*Macrotrachela papillosa* Thompson.
*Macrotrachela habita* (Bryce).
*Macrotrachela quadricornifera* Milne.
*Macrotrachela concinna* (Bryce).
*Macrotrachela aculeata* Milne.
*Philodina nemoralis* Bryce.
*Encentrum Murrayi* sp. nov.

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Since the reports on the earlier series of Spitsbergen mosses, etc., were published, the whole classification of the Class Rotifera has been subjected to most drastic revision and rearrangement. I have therefore thought it desirable in the following list of all the species of Rotifera which have been obtained from Spitsbergen up to the present, to employ the names now in use, but in all cases where these differ from the names given by the authors of earlier reports, to add the latter names within brackets.

| SPITSBERGEN ROTIFERA. | Ehrenberg. | Gregory. | Richard. | Bruce. | Olofsson. | Oxf. Univ. |
|---|---|---|---|---|---|---|
| PLOÏMA. | | | | | | |
| *Proales sordida* Gosse (= *Proales decipiens*) | | × | | | | |
| *Encentrum ferox* (Western) (= *Diglena ferox*) | | | | × | | |
| *Encentrum Murrayi* sp. nov. | | | | | | × |
| *Encentrum permolle* (Gosse) (= *Diglena permollis*) | | × | | | | |
| *Diaschiza gibba* (Ehrenberg) | | | | | × | |
| *Diaschiza gracilis* (Ehrenberg) (= *Furcularia gracilis*) | | × | | | | |
| *Diashicza* sp. 1 incert. | | | | | × | |
| *Diaschiza* sp. 2 incert. | | | | | × | |
| *Keratella quadrata* (Müller) (= *Anuraea aculeata*) | | | × | | × | |
| *Notholca foliacea* (Ehrenberg) | | | | | × | |
| *Notholca foliacea latistyla* Olofsson | | | | | × | |
| *Notholca longispina* (Kellicott) | | | × | × | | |
| *Notholca striata* (Müller) (= *Anuraea scapha*) | | | × | | × | |
| *Notholca striata bipalium* (Müller) (= *N. spinifera*) | | | × | | | |
| *Notholca striata* f. *extensa* | | | | | × | |

| SPITSBERGEN ROTIFERA | Ehrenberg. | Gregory. | Richard. | Bruce. | Olofsson. | Oxf. Univ. |
|---|---|---|---|---|---|---|
| PLOÏMA. | | | | | | |
| *Mytilina bicarinata* (Perty) (= *Diplax bicarinata*) | | | | | × | |
| *Mytilina mucronata* (Müller) | | | | | × | |
| *Mytilina ventralis brevispina* (= *Mytilina brevispina*) | | | | | × | × |
| *Euchlanis deflexa* Gosse | | | | | × | |
| *Euchlanis dilatata* Ehrenberg | | | | | × | |
| *Euchlanis oropha* Gosse | | | | | × | |
| *Lecane brevis* (Murray) (= *Cathypna brevis*) | | | | | × | |
| *Lecane flexilis* (Gosse) | | | | × | | |
| *Lecane rotundata* (Olofsson) (= *Cathypna rotundata*) | | | | | × | |
| *Monostyla bulla* Gosse | | | | × | | |
| *Monostyla cornuta* (Müller) | | | | × | × | × |
| *Monostyla lunaris* (Ehrenberg) | | | | × | × | × |
| *Lepadella acuminata* (Ehrenberg) | | | | | × | |
| *Lepadella ovalis* (Müller) (= *Metopidia oblonga*) | | | | | × | |
| *Lepadella patella* (Müller) (= *Metopidia lepadella*) | | × | | | × | × |
| *Lepadella quadricarinata* (Stenroos) (= *Metopidia bicarinata*) | | | | | × | |
| *Colurella adriatica* Ehrenberg (= *Colurus caudatus*) | | × | | | × | |
| *Colurella colurus* (Ehrenberg) (= *Colurella amblytelus*) | | | | | × | |
| *Colurella obtusa* (Gosse) | | | | | × | |
| *Squatinella stylata* (Milne) (= *Stephanops stylatus*) | | × | | | | |
| *Squatinella tenella* (Bryce) (= *Stephanops tenellus*) | | × | | | | |
| *Scaridium longicaudum* (Müller) | | | | | × | |
| *Lophocaris oxysternon* (Gosse) | | | | | × | |
| *Trichocerca cristata* Harring (= *Rattulus carinatus*) | | | | | × | |
| *Diurella bidens* Lucks ? (= *D. cavia* Gosse) | | | | | × | |
| *Diurella longistyla* Olofsson | | | | | × | |
| *Diurella minuta* Olofsson | | | | | × | |
| *Diurella obtusidens* Olofsson | | | | | × | |
| *Diurella uncinata* (Voigt) | | | | | × | |
| *Polyarthra trigla* Ehrenberg (= *P. platyptera*) | | | × | | × | |
| FLOSCULARIACEAE. | | | | | | |
| *Ptygura melicerta* (Ehrenberg) (= *Œcistes serpentinus*) | | | | × | | |
| BDELLOIDA. | | | | | | |
| *Adineta barbata* Janson | | × | | | | × |
| *Adineta gracilis* Janson | | × | | | | × |
| *Adineta vaga* (Davis) | | × | | × | | × |

| SPITSBERGEN ROTIFERA. | Ehrenberg. | Gregory. | Richard. | Bruce. | Olofsson. | Oxf. Univ. |
|---|---|---|---|---|---|---|
| BDELLOIDA. | | | | | | |
| *Ceratotrocha cornigera* (Bryce) (= *Callidina cornigera*) | | × | | | | × |
| *Habrotrocha angusticollis* (Murray) (= *Callidina angusticollis*) | | | | × | | |
| *Habrotrocha aspera* (Bryce) (= *Callidina aspera*) | | × | | | | |
| *Habrotrocha bidens* (Gosse) (= *Callidina bidens*) | | | | × | | |
| *Habrotrocha constricta* (Dujardin) (= *Callidina constricta*) | | × | | | | × |
| *Habrotrocha elegans* (Milne) (= *Callidina venusta*) | | × | | | | × |
| *Habrotrocha insignis* Bryce | | | | | | × |
| *Habrotrocha lata* (Bryce) (= *Callidina lata*) | | × | | | | |
| *Habrotrocha Milnei* (= *Macrotrachela bidens* Milne) | | | | | | × |
| *Habrotrocha pusilla textrix* (Bryce) (= *Callidina pusilla* var. *textrix*) | | × | | | | |
| *Macrotrachela aculeata* Milne | | | | | | × |
| *Macrotrachela concinna* (Bryce) | | | | | | × |
| *Macrotrachela Ehrenbergii* (Janson) | | | | | | × |
| *Macrotrachela habita* (Bryce) (= *Callidina habita*) | | × | | | | × |
| *Macrotrachela multispinosa* Thompson | | | | | | × |
| *Macrotrachela musculosa* Milne (= *Callidina musculosa*) | | × | | | | |
| *Macrotrachela papillosa* Thompson (= *Callidina papillosa*) | | × | | × | | × |
| *Macrotrachela plicata* (Bryce) (= *Callidina plicata*) | | × | | × | | |
| *Macrotrachela plicata* var. *hirundinella* (Murray) (= *Callidina plicata* var.) | | | | × | | × |
| *Macrotrachela quadricornifera* Milne | | | | | | × |
| *Rotifer sordidus* (Western) | | | | | | × |
| *Roitfer tardigradus* Ehrenberg (= *Rotifer tardus*) | | × | | | | × |
| *Rotifer vulgaris* Schrank | | | | × | | |
| *Pleuretra alpium* (Ehrenberg) (= *Callidina alpium* = *Philodina alpium*) | × | × | | × | | × |
| *Pleuretra Brycei* (Weber) (= *Philodina Brycei*) | | | | × | | × |
| *Philodina acuticornis* Murray (= *P. erythrophthalma*) | | × | | | | × |
| *Philodina brevipes* Murray | | | | × | | |
| *Philodina nemoralis* Bryce | | | | | | × |
| *Philodina rugosa* Bryce (= *Philodina* sp.) | | × | | | | |
| *Mniobia incrassata* (Murray) (= *Callidina incrassata*) | | | | × | | |
| *Mniobia russeola* (Zelinka) (= *Callidina russeola*) | | × | | × | | × |
| *Mniobia tetraodon* (Ehrenberg) (= *Callidina tetraodon*) | | × | | | | |

**Encentrum Murrayi** sp. nov. (Figs. 1–3).

When fully extended and straightened, the body is moderately long and rather slender. It is divided by more or less obvious constrictions into some seven or eight segments. In lateral view the depth of the body is seen to be greater than its thickness. The dorsum is irregularly arched and swollen, but the exact outline is varied continually by incessant and violent contractions, or retractions of head or foot, as the animal swims vigorously about with many turnings and twistings.

The head is somewhat cylindric in form and has a rather low hood-like expansion on the dorsal front. The anterior portion is usually bent somewhat downwards and the hinder part hidden partly within the overlapping of the following segment, a distinct skinfold coming well forward on the head. The face is normally oblique but varies frequently to an almost prone position. The second and third segments have about the same thickness as the head, but the fourth segment containing the greater part of the stomach is notably arched and has generally behind it a moderate constriction. Then follows a less prominent but also swollen segment covering a large intestine. Behind this is a heavy skinfold crossing the body obliquely (in lateral view) and hiding the anus.

The foot has two joints, the upper having a very voluminous skin falling over and partly enveloping the lower joint. The latter, when seen fully outstretched (as in fig. 2), appears distinctly slender and tapering until near to the bases of the toes, where the skin seems tightly clinging. The length of this joint on the ventral side is about twice its depth, and this clearly distinguishes this species from *Encentrum permolle* and *E. ferox*. The toes had the remarkable peculiarity that in some examples they were nearly twice as long as in others. All the earliest specimens seen had the long toes, which in one case measured 48 $\mu$ in length, whilst most of the later had toes of about 25 $\mu$ long only, as in the example sketched (fig. 1). The toes were moderately stout and slightly decurved, the ventral edge nearly straight, the dorsal slightly convex, so that the toes tapered gradually from near their bases to the sharp tips. The bases were set close together, and the toes were strongly divergent.

The trophi (fig. 3) are of much the same type as those of

*Encentrum ferox, E. permolle, E. Hofsteni* and *E. Coëzi.* The rami are of semi-circular form, each terminating in two strong teeth, which I thought were jointed and capable of movement in an inward direction. The fulcrum is of moderate length, about as long as a ramus without the terminal teeth. In ventral view it appears slender, but seen laterally it has a breadth at

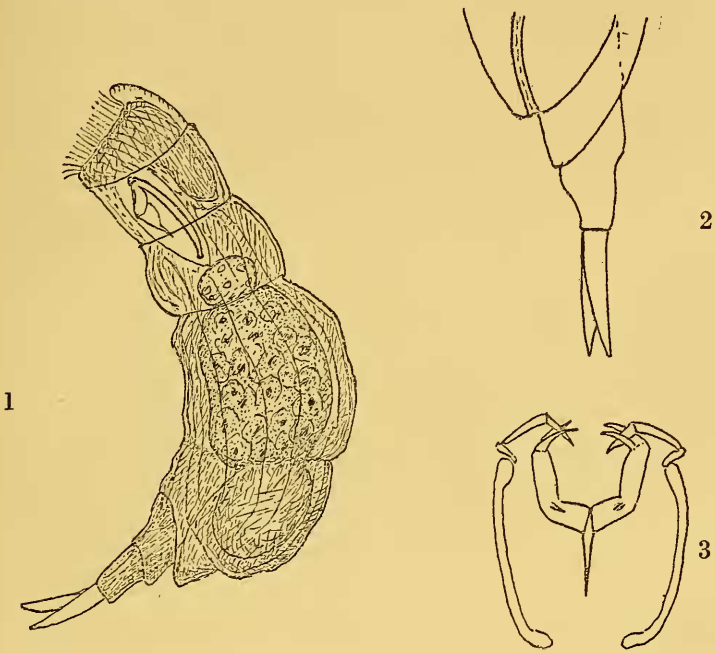


Fig. 1.—*Encentrum Murrayi*, sp. nov. Lateral view (swimming). × 280.
Fig. 2.—Posterior end of body, fullest extension. Lateral view. × 500.
Fig. 3.—Mastax. Ventral view. × 740.

the anterior part of about one-half its length. The breadth rapidly decreases towards its lower end. Each uncus seemed to me to have a terminal short tooth jointed to it and to be itself jointed to a long (about 33 $\mu$) and moderately stout manubrium, which is posteriorly curved inwards and somewhat thickened and rounded at the hinder end. Between the uncus and the manubrium is interposed a small hardened piece, making in effect a double joint. The terminal tooth seemed, as well as I could make out, to be turned inwards and to pass between

the two teeth of the ramus, as I have shown in sketch (drawn to scale from the last of three mastaces dissolved out by use of sodium hypochlorite solution). That three teeth were present appeared quite certain, but their relative position was very obscure, and I could not be sure that the single tooth belonged to the uncus and the paired teeth to the ramus, or vice versa. As my material was exhausted, I could not further investigate this detail. I was also unable to see definitely, first, whether the single tooth was hinged or connected in any way to the paired teeth, or had free and independent movement, and, second, whether it was always thrust between the paired teeth or whether it could also be moved forward beyond them.

In addition to the several parts figured, I saw in this last mastax two very slender rods, in length equal to about one-half the manubrium. Each seemed to be attached to one of the manubria near its junction with the uncus and, to pass thence at about right angles towards the dorsum. I could not more definitely locate them. In the mastax of *Encentrum clastopis* (Gosse), Harring has seen slender L-shaped pharyngeal rods, attached to the incus near the joint of the uncus to the manubrium. These pharyngeal rods are possibly homologous with those of the mastax now described. As in many allied species, the trophi are exsertile and are frequently protruded when the animal is hunting about for its food. One individual which had lived for two days in a trough was found on the third day to have thrust forth the trophi so far that it could not get them back again, and as nothing could be done to help it, it very soon died. Both Milne and de Beauchamp have noted similar instances of dislocation in other species of the genus. I was unable to discern the brain, ovary or contractile vesicle. The latter two were probably obscured by the swollen stomach and intestine. No eyes were observed.

About a dozen living examples were obtained from washings of the "dry tundra" mosses (L 25). When dealt with, the moss was so dry as to be friable. This new form is therefore to be added to the very short list of Ploïmid species, which can protect themselves against desiccation. It is not known whether this protection is afforded by a varnish-like secretion by the alarmed rotifer as in the case of the Bdelloid species, but it seems probable that such is the case.

When swimming and hawking about in search of food, the example sketched most frequently presented a lateral view. It was rarely straightened, but mostly assumed the bent position figured, turning the lower part of the body nearly at right angles to the upper. The skin of the central body was apparently quite without rigidity and so loose as to appear baggy.

Length from 300 to 375 $\mu$ the variation being to some extent dependent upon the length of the toes.

*Habitat.*—Ground mosses.

In the Report on the Antarctic Rotifera already quoted, Murray (6) gives a figure and some few details of a large species of rotifer apparently having a close relationship to that now described, but not agreeing in every respect. As his observations were felt to be incomplete, he did not name his species but contented himself with assigning it to the genus Pleurotrocha. It would now be placed in the genus Encentrum. Notwithstanding several minor divergences in our respective descriptions, I think it probable that the Antarctic form is specifically identical with that now discovered in Spitsbergen moss. I give myself therefore the honour of associating the new species with the distinguished biologist of the Shackleton Expedition by naming it *Encentrum Murrayi.*

*Mytilina ventralis brevispina* (Ehrenberg).

Only isolated examples seen. The type form has been found in several lake and pond collections made by Mr. J. M. Jessup while serving on the Alaskan Boundary Survey (see Harring's report (4) already cited). It has also been found by Olofsson in Spitsbergen.

*Monostyla lunaris* (Ehrenberg).
*Monostyla cornuta* (Müller).
*Lepadella patella* (Müller).

Dead specimens of these three were found along with those of the first-named species. All are included by Harring in his list of Arctic species. *M. lunaris* is stated by him to be "abundant and widely distributed in the Arctic." All three species are recorded by Olofsson (8).

*Adineta barbata* Janson.
*Adineta gracilis* Janson.
*Adineta vaga* (Davis).

These three Adinetae are quite cosmopolitan. *A. vaga* occasionally occurs in pools, but, like the others, is a common inhabitant of mosses.

*Ceratotrocha cornigera* (Bryce).

Since the original discovery of isolated examples of this rather rare species in England, it has been found to be widely distributed. It has now been recorded from Scotland, Switzerland, Canada, Australia, and Peru.

*Habrotrocha constricta* (Dujardin).

One of the commonest of the pellet-making Philodinidae, and widely distributed.

*Habrotrocha elegans* (Milne).

In my earlier report (1), I described the specimens obtained from Dr. Gregory's collections under the name *Callidina venusta*, sp. nov. The species having since been transferred to the genus *Habrotrocha*, Milne's original specific name has again become valid and replaces *venusta*.

*Habrotrocha insignis Bryce.*

The few specimens which I have assigned to this species differed from the type form in showing very indistinctly the curious hardened plate in the head which I thought to be a stiffening for the upper lip, and which I have hitherto found to be somewhat conspicuous. In some examples I could detect no trace of it. Otherwise the specimens agreed with the British form.

*Habrotrocha Milnei* nom. nov. (fig. 5).

I take this opportunity to put forward a new name in place of one given earlier by Milne, when in 1886 he described a pellet-making rotifer closely allied to *Habrotrocha constricta* (Dujardin), but having only two teeth on each ramus, under the name of *Macrotrachela bidens*. In my revision of the classification of the Bdelloida (1910) * this species should have been assigned to the genus HABROTROCHA then created for the reception of all but the most aberrant of the pellet-making forms. But unfortunately the specific name *bidens* had been already employed for Gosse's still older *Callidina bidens*, which was also to be

* Bryce, D., On a New Classification of the Bdelloid Rotifera, *Journ. Q.M.C.*, 2nd Ser., vol. xi., pp. 61–92.

brought into the new genus, and Milne's species was dropped for the time.

I have occasionally found isolated examples which had only two teeth on each ramus, and which strongly resembled the familiar *Habrotrocha constricta* in other respects, differing only

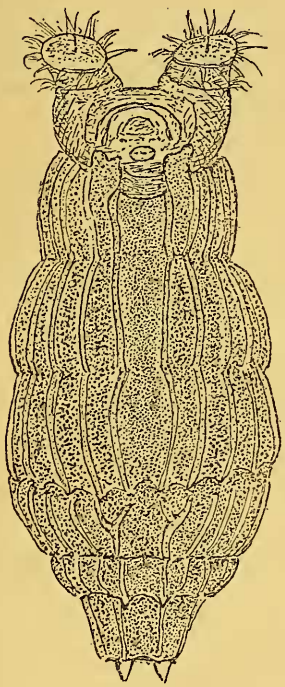

Fig. 4.—*Pleuretra Brycei* (Weber), var. Dorsal view, feeding position. × 500.

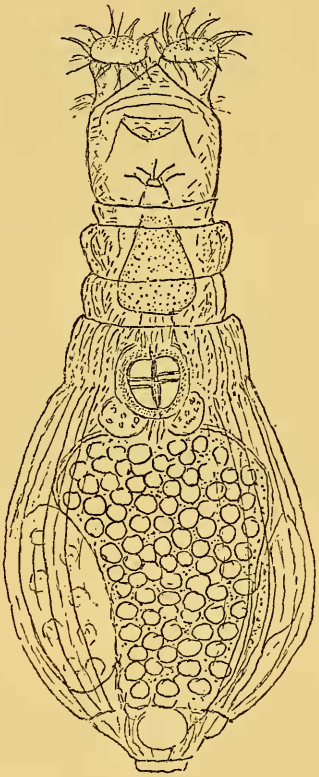

Fig. 5.—*Habrotrocha Milnei*, nom. nov. Dorsal view, feeding position. × 500.

in less important and not very obvious details, and I have felt no doubt that Milne's species was an absolutely valid form. I propose to name it after its discoverer, who was, I believe, the first zoologist in Britain to give attention to moss-dwelling Rotifera and by his earlier papers led the way to a very notable

study which has completely revolutionised our knowledge of Bdelloid Rotifera.

The small trochi and the upper lip resemble those of *H. constricta*, and the general appearance when feeding is very similar. I think it is a rather smaller form than its commoner relative and rather more sturdy in build. The mastax and the brain are in the usual position, the rami have each two teeth, the upper lip is moderately high and centrally is obtusely pointed; the spurs are small cones set closely together, moderately divergent, but less so than in its relative.

The figure (fig. 5) is from an English example.

Length about 200 $\mu$ to 255 $\mu$.

*Habitat.*—Ground moss.

*Macrotrachela aculeata* Milne.

Several examples of this species, which is exceedingly variable, were of the ordinary type found in Britain. It is a very widely distributed species, but occurs only in small numbers.

*Macrotrachela Ehrenbergii* (Janson).

Only recognised among the wet moss from the gatherings Z 1 and 2. Besides the adults, some of the characteristic spinous eggs were seen.

*Macrotrachela concinna* (Bryce).

Several specimens were seen in the washings from the "dry tundra" (L 25).

*Macrotrachela habita* (Bryce).

This species occurred in five different gatherings. It is one of the most widely distributed of moss-dwelling Bdelloida, and is extremely hardy. It is exceedingly variable in minor details. Murray has recorded its presence in the lakes near Cape Royds (6), where the local form was noteworthy for the deep crimson colour of the stomach. The Spitsbergen examples seemed typical in all respects.

*Macrotrachela multispinosa* Thompson.

Only one example of this most variable species was detected. It had the ordinary spines of medium length.

*Macrotrachela papillosa* Thompson.

I think only one example of this variable species was found, and in the "dry tundra" (Z 25). This form was also seen in the 1896 collections.

*Macrotrachela plicata hirundinella* (Murray).

Some dead specimens could be recognised as belonging to this variety. The distinctive processes were only of medium length. The type form was seen in the 1896 collections, but was not detected in the present series. Both the type form and this variety were seen by Murray (5).

*Macrotrachela quadricornifera* Milne.

A few specimens of this cosmopolitan species also occurred in the "dry tundra" (L 25).

*Rotifer sordidus* (*Western*).

The specimens seen of this variable species seemed to be all typical. They came from the ground moss from Cap Boheman and from the "dry tundra" from Klaas Billen Bay.

*Rotifer tardigradus Ehrenberg.*

The few specimens seen were all of the ordinary type, and call for no comment.

*Pleuretra alpium Ehrenberg.*

This species is noteworthy as the only rotifer recognised by Ehrenberg when in 1869 he examined some mosses which had been collected in Spitsbergen in 1867.

It occurred in the mosses which I examined in 1897. On the present occasion no single one of the few specimens seen showed any sign of life. Also seen by Murray (5).

*Pleuretra Brycei* (Weber), var. (fig. 4).

I found in the mosses from the gatherings L 19 and L 21 a practically spineless form which I have thought it worth while to figure in its customary feeding position, as no really satisfactory figure of this usually spinous and exceedingly variable species has yet been published. The type form has a transverse row of spines arising from the longitudinal skinfolds of the back, where these reach the rear of the third segment of the central body. At this point the skinfolds, which are rather stiff and

strongly marked, are suddenly cut off and the ends of the ridges are produced into more or less short yet conspicuous thorn-like spines. The long row of 8 or 10 spines, crossing the back just below the middle, is frequently supplemented by a shorter row of 4 or 6 lesser spines on the hinder margin of the following segment and sometimes at least by two more spines on the next after that.

The anterior margin of the first central segment seems to be almost invariably furnished with a pair of rather solid-looking processes, frequently slightly furcate, which stand to right and left of a small medial dorsal sinus. In the variety now observed the processes just described were present though shorter and less furcate than usual; but the spines of the usual long row crossing the back were not developed. The skinfolds terminated in angular projections which could not be called spines. Two very short and blunt points seemed present to right and left of the central portion of the rear margin of the fifth central segment, but they could only be glimpsed occasionally. In other respects the specimens seemed normal. This species usually inhabits mosses growing in wet places and has proved to be very widely distributed, and very variable in the number and exact disposition of its spines. I do not think that a spineless form has yet been recorded, and in view of the great range of variation possessed by the species, I have not thought it desirable to separate these specimens as a new species. Some specimens approaching the type form were seen by Murray (5).

*Philodina acuticornis* Murray.

The specimens referred to in 1897 as *P. erythrophthalma* and of which I made some sketches at the time, did not belong to the species now regarded as the true *P. erythrophthalma* Ehrenberg. They seem rather to be indistinguishable from the species, a rather variable one, described by Murray some years later. Some specimens seen in the L 21 collection have also been assigned to the same species, which is one of the most puzzling in the genus, and one of the most widely distributed.

*Philodina nemoralis* Bryce.

A few specimens of this moss-dwelling species, rarely found in ponds, were present in the "dry tundra" (L 25). In some

mosses brought to me from the Faroë Islands by Mr. Earland some years ago I found numerous examples of this easily recognisable species.

*Philodina rugosa* Bryce.

To this species are to be assigned some rough-skinned Philodinae referred to in my report of 1897 as *Philodina* sp.

*Mniobia russeola* (Zelinka) (fig. 6 *a–d*).

This large and handsome rotifer, which occurred in the gatherings of 1896 and was also seen by Murray (5), was present in three collections, one from each of the three localities whence moss was taken. Its presence proved specially interesting. The solitary example seen in the washing of the Z 1 gathering was found, on being isolated, to have within its body a vermiform parasite, which was recognised as one which I had seen on two previous occasions in British specimens of the same rotifer. At a later date another individual from the L 21 moss was found to be infected by the same parasite, and from this latter were obtained some details which I had not been able to make out on previous occasions.

*Mniobia russeola* is a rather stoutly built Bdelloid rotifer whose body when fully extended is somewhat larviform, and divided into fifteen segments, the anterior six forming the head and neck, the following six the trunk (or central body), and the last three a very short foot. Adult individuals are usually at least 600 $\mu$ in length, and I have seen them up to nearly 800 ft. long. The skin is transparent. When the animal feeds it usually assumes a somewhat squatting position. When undisturbed it will often continue quietly feeding for hours with scarcely any change of position. In the genus Mniobia, as in most of the other Bdelloid genera, the stomach is a long sausage-like organ occupying a large proportion of the cavity of the trunk. It has a thick wall consisting of more or less minutely granular tissue packed between two membranes or tubes, one within the other, the inner lining forming cavity of the stomach, the outer the actual lumen or the exterior coat of this organ. Behind the stomach and usually separated by a constriction controlled by a sphincter muscle, is a short bladder-like intestine. Behind the intestine is a contractile cloaca, which combines the functions of a contractile vesicle (as found

in Rotifera other than Bdelloida), and of a cloacal passage leading to the anus.

When I detected the parasite in the *M. russeola* from the Z 1

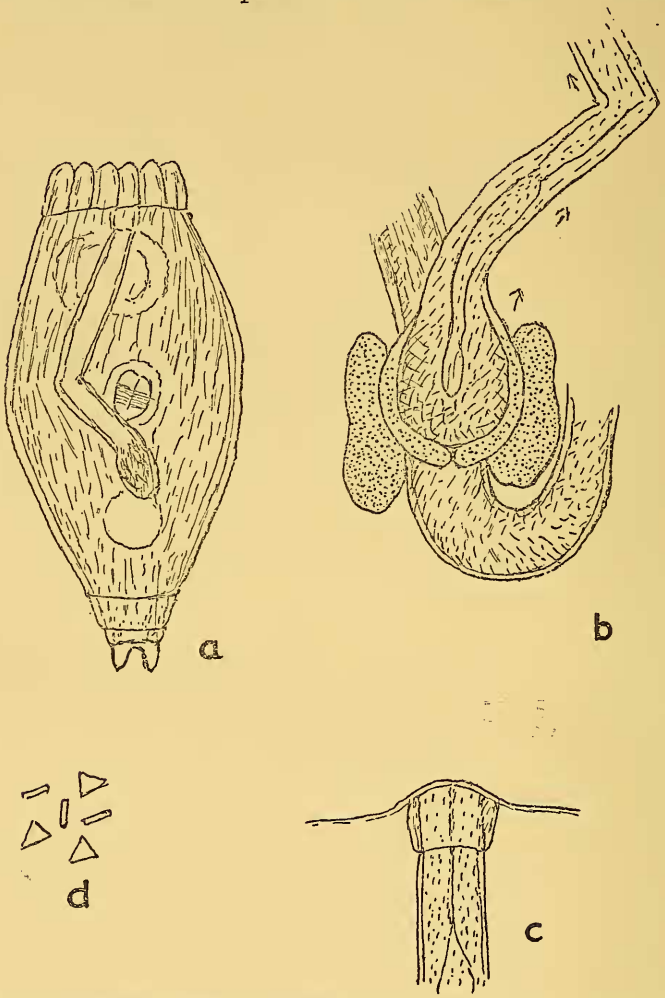


Fig. 6.—Parasite of *Mniobia russeola*: *a*, parasite in situ; *b*, head of parasite more highly magnified; *c*, posterior of ditto; *d*, particles among blood corpuscles of *Mn. russeola*.

moss, I transferred the host to a shallower cell wherein the rotifer could not move freely. It was in fact so uncomfortable that it

did not resume feeding but contracted into the position shown (fig. 6 *a*) wherein the head and neck are retracted within the central body. (The internal organs of the rotifer are omitted or barely indicated, so that the position taken by the parasite may be more clearly understood.) This position of the parasite has been approximately identical on all four occasions. The parasite is shown with its head resting upon or gripping in some way the lower part of the stomach near its junction with the intestine (see also fig. 6 *b* drawn from the second Spitsbergen example). Behind the head of the parasite follows a long tubular body, which passes nearly to the side of the rotifer and then abruptly changing its course passes forward to the anterior dorsal margin of the seventh segment of the rotifer (i.e. of the first central segment), almost in the median line. Thus the parasite has its posterior extremity well forward in the rotifer, while its head is far to the rear. I was able to make out a terminal and somewhat thickened segment (fig. 6 *c*). At the point stated above, the skin of the rotifer seemed to be pushed upwards and outwards in a gentle swelling (fig. 6 *c*). I had proof later that at this point the parasite maintained its communication with the exterior of the rotifer, and it is suggested that it is probably also the point where the parasite had gained admission to its victim's body, penetrating through the softer integument of the invaginated skin between the sixth and seventh segments of the body of the rotifer. So far as I could make out, the parasite seemed by sucking with its head or mouth to be swallowing fluid drawn from between the two membranes of the stomach wall of the rotifer. At intervals of from 30 to 60 seconds, occasionally even more, the long central body of the parasite gradually distended and then suddenly collapsed, becoming only discernible with difficulty, but presently coming gradually into view again as a long bladder apparently containing fluid only. The collapse although nearly instantaneous in its action throughout almost the whole length of the central portion of the parasite was not quite so. I noticed that the movement began near the head, and that the muscular impulse involved, whatever be its exact nature, travelled from the head backwards to near the posterior segment. While the tube was being distended the portion immediately before the terminal segment was apparently unaffected, but I succeeded in seeing

that when the collapse of the tube occurred, this portion was momentarily distended. These more intimate details were being obtained from my second example (whose host, after isolation, I had left in greater freedom and which was steadily feeding all the time), when a movement in the rotifer attracted my eye, and I then glimpsed some particles passing quite rapidly through the distended tube of the parasite. I had scarcely realised what was happening when the particles were ejected into the water outside the rotifer, issuing from the point where I had located the posterior extremity of the parasite. The particles seemed to me, as they floated in the water, to be portions of the granular tissue lying between the two membranes of the wall of the stomach of the rotifer.

At each side of the head of the parasite I could see an elongated body suggesting a gland, with minutely granular contents. These external bodies seemed undoubtedly to belong to the parasite. Their contents seemed to be moved occasionally by some pressure as they changed position. I also observed some slight independent movement in the anterior part of the head of the parasite. As a general rule the head did not change its position, but now and again I saw a slight movement as though it was altering its hold.

What I could make out of its head will be best understood from fig. 6 *b*, where it is shown *in situ* on the exterior of the stomach of its host. It seemed to have an external definable integument, which in front was not continuous, but as though there was there some opening. Within the integument was what I took to be mainly a muscular structure with a small central cavity communicating with the distensible tube behind. The lateral gland-like bodies I have already described.

I estimated the length of the second parasite as about 300 $\mu$ if straightened out.

When I examined the host it was evident that, although feeding without cessation, it was not in a normal condition. The last two segments of the central body, known as the lumbar (or preanal and anal) segments, were unusually distended and the organs there located could not be defined. The contractile cloaca, which normally fills and empties itself every minute or so, was not acting at all. The inference was that the parasite was drawing and expelling so much fluid from the

rotifer that there was none left for the contractile cloaca to deal with.

A day later the rotifer was distinctly weakened, and as I was temporarily leaving home I essayed to make a preparation showing the parasite *in situ*, but did not get a satisfactory result.

The parasite may be shortly described as an animal apparently belonging to the Vermes, having a distinct head, a long tube-like unsegmented central body and a distinct terminal segment. Whether it is identical with any form already known has not yet been ascertained. All internal parasites hitherto recorded for rotifera have been either very minute protozoa, algae, amoebae, or bacteria. This form is very much larger than any of these, and of much more specialised structure. It had previously been seen by me in a specimen of the same rotifer from Perranporth (Cornwall) and in another from Killin (Perthshire). The host is almost exclusively an inhabitant of ground mosses and is a very hardy and long-lived species, usually of distinctly reddish-yellow colour.

This second infected individual from Spitsbergen had another very interesting abnormality which may or may not be connected with the presence of the parasite.

In this species and in one or two other large forms, the fluid of the body cavity contains numerous very fine particles which have been regarded as blood corpuscles. In this individual I observed among such particles some larger particles, about a dozen in all, which, like the small, were driven hither and thither by every change of position of the rotifer. Of these larger particles some seemed longer than broad, others appeared triangular in form. I presently found that the former were identical with the latter, and simply represented their lateral aspect. The triangular forms were accordingly flattened tablets, each side about 5–6 $\mu$ long, with approximately equal angles (fig. 6 *d*).

## Tardigrada.

Although water-bears were found in several gatherings of moss, only a very few individuals were revived, representing two distinct species. One of these was a Macrobiotus, which I did not attempt to identify more closely. The second proved to be *Echiniscus Spitsbergensis* Scourfield, a species first discovered in

the mosses brought from Spitsbergen by Dr. J. W. Gregory in 1896. In the individual which I compared with Scourfield's (10) figure and description, the posterior processes were distinctly more developed. Murray (7) has recorded this species from Loch Morar in Scotland.

It is my duty to express my grateful thanks to Mr. C. S. Elton for much help in the preparation of this report.

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The following works are specially referred to by figures in brackets, after the names of authors, etc.:

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(9) Richard, J.: Sur la faune des eaux douces explorées en 1898 pendant la campagne du yacht *Princesse Alice* (Lofoten, Spitsberg, Iles Beeren, Hope, de Barents et Faeroer), *Mem. Soc. Zool. France*, vol. xi, Paris, 1898, pp. 326–338.

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